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Phenotypic Plasticity of Crops and Adaptation to Stress Environments

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Abstract

Adaptation of crops to stress environments is mostly seen as a function of physiological tolerance capabilities, enabling the plant to continue growing despite a stress condition. Osmotic adjustment is one such mechanism. Frequently more important, and more accessible to breeding, are constitutive avoidance mechanisms residing in the plant's body plan, such as deep root systems, that reduce exposure to stress factors. Much less understood is the contribution of phenotypic plasticity to agro-ecological adaptation. Phenotypic plasticity is the ability of the plant to adjust its morphology, architecture and phenology to environmental conditions in the course of its ontogeny. The result is an infinite number of different phenotypes that can be produced by a given genotype. This paper presents ongoing, experimental and modelling research on adaptive morphogenesis. The interaction between environmental stimuli (such as photoperiod), physiological stress conditions (such as phosphorus deficiency) and competition among sinks for assimilates is discussed using oil palm, sorghum and rice as examples. The paper proceeds with the presentation of a new modelling approach called EcoMeristem, which flexibly builds plant architecture, and simulates resource use and stress conditions, on the basis of genotypic reaction norms. At the core of this approach are the meristems, capable of sensing metabolic and environmental signals, and adjusting structural growth to these signals. The authors conclude with an outlook on future applications of this model in crop breeding, functional genomics and development of improved plant type concepts for stress environments.

Keywords: Osmotic adjustment, EcoMeristem

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